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## **The use of archaeological and anthropological methods in fatal fire scene investigation.**

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## **Abstract**

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### **The use of archaeological and anthropological methods in fatal fire scene investigation.**

This report will highlight some of the techniques and technologies of archaeologists and anthropologists that may be of assistance in fatal fire scene investigation. The value of archaeological techniques has been previously acknowledged in fire scene recovery and the primary principals of excavation are often applied; however the full range of methods and techniques available has not yet been fully exploited. Many additional aspects of archaeological and anthropological work can be adapted and applied to fatal fire scene investigation to provide further opportunities to maximize evidence recovery and interpretation. The application of some of these techniques does require evidential proof of value, as well as research into how best to use these systems. These research avenues and identified areas of need will be discussed to consider where future research may be beneficial.

## **Resume**

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### **L'utilisation de méthodes archéologiques et anthropologiques dans une enquête sur les lieux d'un incendie mortel**

La présente étude montrera certaines techniques et technologies employées par les archéologues et les anthropologues qui pourraient servir à une enquête sur les lieux d'un incendie mortel. L'utilité des techniques archéologiques en matière de récupération sur les lieux d'un incendie a déjà été reconnue et les principes fondamentaux des fouilles sont souvent appliqués, mais l'éventail complet des méthodes et techniques disponibles n'est toujours pas exploité entièrement. De nombreux autres aspects du travail archéologique et anthropologique peuvent être adaptés et appliqués à une enquête sur les lieux d'un incendie mortel pour optimiser la récupération et l'interprétation des preuves. L'application de certaines de ces techniques demande d'avoir des preuves de leur valeur et des recherches concernant la meilleure façon d'utiliser ces systèmes. Ces pistes de recherche et les besoins sectoriels décelés seront abordés pour déterminer quelles autres recherches pourraient être utiles.

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# 1 Introduction

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Fatal fire scenes generate investigative challenges for police, fire investigators, medical investigators and other personnel required to assess and analyze the scene. Fire and burning can result in considerable destruction and alteration of human remains, building structures and other associated evidence and any mechanisms which can aid in the understanding of the fire scene will greatly assist the role of investigators. Archaeological and anthropological techniques are such mechanisms, which, when appropriately applied, can aid fatal fire scene investigation.

The primary aims of archaeological excavations are to document and recover evidence systematically to enable its correct interpretation. By assessing the positioning and location of objects and remains archaeologists are often able to infer relationships between objects and understand the significance of one element to another. Archaeologists are then involved with the recovery of evidence and remains from the scene. Following this recovery, anthropologists are able to analyze the human skeletal remains and develop an osteobiography, which is the process of detailing aspects of individual identity and events occurring near the time of death. By assessing features throughout the skeleton, an individual's age, sex, stature and, on occasion, biological affinity can be determined. Anthropologists can also assess the remains for evidence of trauma and are often able to differentiate evidence of ante-mortem, peri-mortem and post-mortem traumatic events. This analysis is highly dependent upon the volume of osteological material available for assessment, the area of the body that is represented and the condition of the remains. The archaeological and anthropological outcomes of excavating a site and completing remains assessment correlate very closely with the aims of forensic investigations. As such, applying archaeological principals in the excavation of a fatal fire scene has the potential to aid investigators by maximizing evidence discovery, reducing evidence destruction and enabling a more thorough and meaningful anthropological assessment and interpretation of the human remains. The two areas of archaeology and anthropology are very closely related and experts in one area often have skills in the other. To avoid confusion in this report the term archaeology will be used to refer to the discovery, excavation and recovery of remains and anthropology will be used to refer to laboratory based analysis of human remains.

This report will highlight some of the techniques and technologies of archaeologists and anthropologists that may be of assistance in fatal fire scene investigation. The value of archaeological techniques has been previously acknowledged in fire scene recovery and the

primary principals of excavation are often applied; however the full range of methods and techniques available has not yet been fully exploited. Many additional aspects of archaeological and anthropological work can be adapted and applied to fatal fire scene investigation to provide further opportunities to maximize evidence recovery and interpretation. The application of some of these techniques does require evidential proof of value, as well as research into how best to use these systems. These research avenues and identified areas of need will be discussed to consider where future research may be beneficial.



## **2 Identification of areas of anthropological/archeological technologies and techniques that have not been fully exploited and utilized by police/fire forensic investigators**

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### **2.1 Remains Discovery**

The first aspect of remains discovery that could be enhanced by using archaeological training is the discovery of scene location. While not a common occurrence, circumstances do arise where burnt remains have been moved, buried or otherwise concealed, making their discovery more challenging. Archaeological methods of scene identification incorporate a range of strategies as such environmental assessments and consideration of factors which may affect the remains following death such as remains dispersal due to animal disturbance, water currents and gravity (recognizing and interpreting these factors is a specialized field of study in anthropology called taphonomy). In combination with this, archaeologists are also trained to identify soil disturbances such as signs of digging, soil displacement and re-filling. These skills enable archaeologists to identify general, as well as specific, areas of potential remains location. Although typically applied to historical sites, the identification of scene locations can be adapted for more recent events with some additional considerations made for smaller time scale factors and case specific information.

A more common difficulty faced in fatal fire scenes is the discovery of human remains within an identified scene. Depending upon the degree of remains destruction, a body can be partially or fully reduced to burnt bone fragments that can be very difficult to discover when mixed with fire debris. The search for burnt fragments can be facilitated by using an archaeological method of grid or zonal searching. By focusing the search on smaller areas and ensuring no area is overlooked the volume of remains discovery can be increased. Furthermore, by searching in a systemic format, starting from the area of least destruction moving to the area of greatest destruction, investigators can ensure that no area of the scene is disturbed more than necessary. On-scene systematic searching will also reduce the potential for remains destruction as remains are not moved or disturbed (or only minimally disturbed) prior to discovery.

In addition to grid or zonal searching, the use of archaeological excavation techniques also enhances remains discovery. Methodical, small scale removal of debris surrounding a body, or object, facilitates the discovery and recognition of small associated elements such as teeth and

finger bones. This can be further enhanced in some circumstances by using a system of block recovery where an object is not excavated in the field, but in the laboratory. When using block recovery for particularly fragile objects archaeologists remove an entire block or area of matrix (in the case of fire scenes fire debris and firm base) without disturbing the object itself. This is then excavated in a more stable and controlled environment in the laboratory. Care needs to be taken when using this method to include a large enough area in the block and not to disturb the remains during the removal process. Block recovery will not be appropriate for all scenes and its use will depend on the condition of the remains and the nature of the surrounding matrix, as well as the proximity of the lab.

A further method to maximize remains discovery is the use of screens to filter the fire debris. By passing all fire debris through the screen investigators view single layers of debris of similar size, increasing the chance of identifying remains. Screens must only be used as a *final* search system, after efforts have been made to identify and directly recover remains in their original location. The use of screens increases the likelihood of incurring additional damage to remains and the subsequent loss of information.

For all these search techniques it should be noted that their success is closely linked with the searchers ability to correctly identify material as human remains. As bone burns the organic content is progressively lost in a process known as calcination that also increases remains fragility and deformation, leading to the reduction of remains to calcined bone fragments. These fragments are typically small, grey-white in colour and may not resemble the bone in its original form. As such, individuals searching the scene would benefit from some training in the identification of burnt remains, or the opportunity to view exhibits of burnt bone. Difficulties associated with the identification of burnt bone could also be addressed by research into the use of alternative light sources for scene searching. This has been provisionally investigated in crime scene contexts with positive results<sup>1</sup>.

## **2.2 On-scene remains analysis**

A second area of archaeological methodology that has been identified as offering potential benefits to fatal fire scene investigation is the use of excavation methods for the

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<sup>1</sup> Marvin, T. 2001 Fluorescence of Bone and Teeth with Ultraviolet and Alternate Light Sources Including Cremated Human Bone. *Identification Canada* Oct/Nov/Dec, 12-13.

preservation and documentation of context. Context can be described as the position of an object and its relationship with the surrounding area and other evidence. Context is of central importance in any investigation. Without direct knowledge of how a specific piece of evidence fits into the scene as a whole, scene reconstructions and evidence analysis can be severely constrained. One of the primary goals of archaeological excavations is to observe and document contextual information and applying some of these principals to fatal fire scenes could prove highly beneficial.

In archaeological excavations the documentation of context requires remains to be first observed *in situ*, or on scene in their original position. For some aspects of fire scenes this may be relatively straightforward, such as removing large pieces of surface debris when recovering evidence from the surface layer of rubble. When recovering evidence from within the rubble layer this is more complex. Removing small areas of debris with a trowel, or appropriate tool, allows evidence or remains to be identified and preserved in their original (or close to original) position ensuring that their context and relevance can be assessed and documented prior to removal. For very fragile objects this approach may provide the only opportunity to record this type of evidence.

Excavating a scene using archaeological principals of layered removal also allows the relative vertical positioning of evidence to be recorded. Determining the position of an object or remains as above or below other objects may offer some insight into relative pre-fire positioning and thus provide some information on events occurring in the build up to the fire. If debris is not searched and observed *in situ*, these contextual relationships are lost and cannot be reconstructed. This aspect of archaeological recovery of fire scenes requires further investigation to learn how objects or remains can move as a result of the burning process or associated structural collapse. It is a logical belief that vertical relationships prior to the fire would be maintained to some degree in the post-fire environment; however, the effects of falling debris and the mechanisms by which structures collapse need to be investigated to ensure that evidence of locality can effectively stand up to any legal challenge.

Associated with evidence of relative vertical locality, the use of grid or zonal systems of scene recovery allows relative horizontal locations to be recorded. While the destructive nature of fires does result in the movement and alteration of evidence, the generalized positioning and distribution of evidence and remains can still be mapped and can provide important investigative insights. For example, finding remains near an exit way may suggest attempted escape whereas

discovering remains in the centre of a room may initiate questions as to why no escape was attempted. Furthermore, a wide distribution of remains can raise suspicion of dismemberment or an explosion prior to burning, whereas discovering remains located in a number of discreet locales may suggest the burning of more than one individual. When working at scenes with more than one decedent, documentation of the original position and orientation of the recovered elements can greatly assist in sorting remains and can prevent issues associated with commingling.

## **2.3 Remains recovery**

The recovery of remains from a fatal fire scene is another area in which the use of archaeological methods can be of assistance. Following discovery and *in situ* documentation, there is the need for the remains to be recovered, packaged, and transported to a laboratory or morgue for continued analysis. The aim of this removal process is to prevent any further destruction, and this, too, can be enhanced by using archaeological techniques. The first of these is the use of archaeological excavation methods and tools to remove debris. When excavating, archaeologists aim to remove all surrounding matrix without moving or damaging the article of importance. This helps to maintain the object's integrity and ensures it is not inappropriately or unexpectedly altered by the excavation process. When excavating burnt human remains this is especially important as calcined bone can be very brittle and fragile, collapsing and fragmenting at the slightest disturbance. Following the removal of debris the object can be assessed and documented *in situ* prior to removal from the scene.

The lifting or removal of remains from the scene is often a difficult process in which the integrity of the fragile material can easily be compromised. This process can be aided by using archaeological methods of stabilization through the use of consolidants. Consolidants are substances, typically liquids, which when applied to objects increase their structural strength and help to prevent destruction. Consolidants are often used in long term stabilization although removable consolidants have been developed for in field application. While the use of consolidants is not always ideal, especially in the field where matrix and fire debris may adhere to, or even fuse with, the object, they can be very useful for the stabilization of calcined bones. Examples of consolidants previously used for burnt bone include polyvinyl acetate, methyl acrylate/ethyl methacrylate copolymer, and polyvinyl butyral solutions. Despite the potential value of consolidation the use of these substances at forensic scenes does require further

investigation. The effects of consolidants on laboratory analyses are not fully understood and the use of any substances that would interfere with trace analysis or the extraction or integrity of DNA need to be avoided.

In addition to the use of consolidants, appropriate methods of packing and transport can also reduce remains destruction. The use of pliable body bags is not ideal as without a firm base support the fragile remains are prone to movement and increased destruction. Placing the remains in a box, or on a board in a body bag, will greatly reduce this movement associated destruction. Placement of smaller elements in boxes, or paper bags, supported in acid free tissue paper or other padding (including bubble wrap) will also help to minimize their disintegration.

### **3 Identification of needs of forensic investigators that could be addressed by focused anthropology/archeology related research**

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Although the use of archaeological and anthropological systems can greatly assist forensic investigators at fatal fire scenes a number of challenges still exist. Some of these could be aided by using archaeological or anthropological knowledge and expertise after focused, fit-for-purpose research is conducted into the methods and systems of evidence collection, analysis and interpretation. Some of this potential research has been mentioned in Part 1 where it pertains to advancing or adapting archaeological techniques. In this section areas of need in fatal fire investigations that could be aided by archaeological or anthropological related research are discussed.

#### **3.1 Remains Discovery**

Increasing the volume of remains discovery is an important goal for improving anthropological assessment of burnt remains. One way in which this could be achieved is through research into the movement of remains during a fire event. Knowledge of how remains disperse will allow investigators to set search perimeters or zones to increase the chances and efficiency of remains discovery. This is especially important for the recovery of teeth and small elements of the hands and feet which often separate from the primary body mass. The recovery of these elements is significant as dentition often provides a means of positive identification, and bones of the hands may show evidence of defense wounds or other trauma. Other systems of improving remains discovery, such as increasing each searcher's ability to recognize burnt material, have been previously discussed.

Another area of research associated with remains discovery is the differentiation of human and animal remains (such as pets and food items and refuse). Although this is seldom a challenge for trained archaeologists and anthropologists, it is not always a simple distinction for fire scene investigators. The development of a simple system of differentiation would assist fire scene investigators in that it would enable a rapid assessment of the likelihood of having discovered human remains. This system would need to be developed in such a way as to ensure

that human remains cannot be misclassified as animal remains, but that animal remains can be identified as such.

### **3.2 On-scene remains analysis**

While the use of archaeological systems of excavation allows the relative location and context of objects to be documented, the significance of these locations and thus the value of this evidence of locality for fatal fire scenes is an area requiring further investigation. The burning process can cause changes in remains or object locations, and scientific research is required to ensure that this post-burning movement is understood and can be factored in to any interpretation of remains location. Body location and position are significant indicators of pre-fire activities and actions and appreciating how remains may move during the fire will ensure the accurate and reliable use of this information. Identification of natural processes of remains movement will also enable investigators to distinguish fire and human related interference with remains. This could have significant impacts when determining the criminal nature of a scene.

### **3.3 Remains recovery**

Remains destruction during recovery is a key problem faced by investigators when processing fatal fire scenes. Remains are very fragile and prone to degrade at the slightest disturbance. Research aimed at reducing this destruction and improving remains recovery is important and would greatly aid investigations. Previously discussed approaches to improving remains recovery include the use of consolidants and improved packaging and transport protocols.

### **3.4 Remains Taphonomy**

In addition to the areas outlined above, a further area of research which could have a significant impact on fatal fire investigation is remains taphonomy, an area of research that focuses on determining how remains are affected by their environment. This research would have two avenues of importance for investigators: determining the effects of natural taphonomic processes on bone morphology will aid the identification of signatures indicative of human induced trauma; and, by understanding how the fire environment affects remains in different circumstances, investigators will be able to interpret taphonomic signs better, indicating how the

burning process occurred. This research will also have potential benefits for remains discovery and recovery.

One aspect of taphonomy which would greatly enhance fatal fire scene investigations is an understanding of fire related destruction of remains. Determining what level of destruction is typical under what circumstances will enable investigators to determine if the remains exhibit patterns concurrent with the proposed course of the fire. Furthermore, understanding the degree of destruction that is associated with the burning process, the methods of fire suppression and the process of recovery will allow further research into methods of limiting this destruction, thus improving remains recovery. This benefit could be further extended by investigating the effects of time between burning and recovery on remains friability. Remains continue to degrade following fire suppression and by understanding the time course of this destruction it may be possible to alter recovery systems to ensure maximal recovery. Furthermore, understanding how remains are altered with time may allow the development of protocols to reduce this time-associated breakdown. These approaches may be as simple as maintaining the moisture content and preventing desiccation; however, the exposure of burnt bone to water can also have negative effects on remains integrity.

For all taphonomy based research it is important to understand the effect of variables intrinsic to the remains. Determining how remains from fetal through to elderly aged individuals differ in their responses to the burning and post-burning environments are essential aspects for investigation. Age has a significant impact on the osteological composition of remains and thus bone reactions can be expected to differ in different age groups. Other variables such as body mass, fat composition and diseases affecting bone may also influence how the remains react and degrade in fire scenes. An understanding of how intrinsic body variables affect the burning of remains may also enhance scene excavation and remains recovery. As remains are expected to respond differently to the burning environment, it follows that different protocols and systems of recovery may be required depending on the nature of the remains. The assessment and development of different protocols cannot be completed until there is a more thorough understanding of how remains respond to fire, and the causes of remains destruction.



## **4 Prioritization of elements identified in parts 1 and 2**

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A number of archaeological technologies and future research opportunities that would aid fatal fire scene investigation have been described in parts 1 and 2. From these sections it is possible to determine areas of high priority that would offer the greatest benefits to investigators. It is important to base this prioritization on a wide range of factors such as ease of implementation, current restrictions, potential for further improvement, and value of return. To conduct this prioritization analysis for elements identified in this report each broad area outlined in parts 1 and 2 will be reviewed, highlighting aspects of importance and possible restrictions.

### **4.1 Remains discovery**

- The use of archaeological techniques of scene location can be very beneficial; however, circumstances where these skills may be required are not common.
- The use of grid searches aids remains discovery through focused and structured searching of small areas.
- The use of grid searches ensures remains or other evidence is disturbed as little as possible outside of the documented search process.
- The use of block recovery techniques may aid discovery of remains; however, research into how best to implement this procedure in fire scenes is required.
- Research into methods of identifying the appearance of the various stages of burnt bone is required to maximize the value of scene searches.
- Research into the use of alternative light sources could aid remains discovery.
- Research into the movement of remains would aid remains discovery by improving search localization.
- Research into methods of differentiating burnt animal and human can aid in determining the presence of human remains.

### **4.2 On-scene remains analysis**

- The use of archaeological methods of recording and interpreting context can provide vital investigative clues.

- *In situ* assessment of evidence and remains can greatly enhance scene investigation by allowing a full understanding of the burning process and the development of accurate scene reconstructions.
- *In situ* assessment of remains may enhance remains interpretation if subsequent degradation prevents further analysis.
- Research into the reliability of contextual relationships is required before the true interpretative value of recording context can be determined.

### **4.3 Remains Recovery**

- The use of archaeological systems of recovery can reduce destruction.
- The use of appropriate packaging and transportation for remains can reduce destruction.
- Research into the effects of the use of consolidants for remains stabilization is required.

### **4.4 Remains Taphonomy**

- Research into the production of natural taphonomic signatures generated in the burn environment is vital for the correct interpretation of burnt remains.
- Research into taphonomic processes of remains destruction will enable improvements to methods of scene search and recovery, enhancing remains analysis.
- Research into how variables intrinsic to the remains affect taphonomic processes is important to ensure accurate and reliable remains interpretation.

Considering these summaries some areas of high priority are clearly evident. The first of these is research into enhancing discovery and recovery of remains. While burnt remains analysis is possible, it is limited by inefficient recovery of remains. Increasing recovery effectiveness and reducing damage or destruction of material are important areas for the implementation of archaeological systems and future research. In addition to this, fatal fire scene investigation will also be greatly enhanced by improved understanding of the effects of fire on remains, i.e.

taphonomy. Appreciating how remains respond to the burn environment will allow investigators to interpret correctly the evidence of burning or human induced trauma. Research specifically into taphonomic remains destruction will also aid discovery and recovery of remains. A third area of research focus is the value and significance of context and contextual relationships. While these are the cornerstones of any archaeological excavation and have significant potential for fatal fire scenes, research needs to be conducted to ensure that the interpretation of contextual relationships is accurate and reliable. Until this research is completed specifically for fatal fire scenes the significance of contextual relationships could be called into question and thus the time-consuming detailed recording of this information may not be justified. It should be noted that this research would build upon established principles of remains location currently used in investigations and would enhance remains interpretation by allowing a more insightful appraisal of the scene.

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## Resume

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### L'utilisation de méthodes archéologiques et anthropologiques dans une enquête sur les lieux d'un incendie mortel

La présente étude montrera certaines techniques et technologies employées par les archéologues et les anthropologues qui pourraient servir à une enquête sur les lieux d'un incendie mortel. L'utilité des techniques archéologiques en matière de récupération sur les lieux d'un incendie a déjà été reconnue et les principes fondamentaux des fouilles sont souvent appliqués, mais l'éventail complet des méthodes et techniques disponibles n'est toujours pas exploité entièrement. De nombreux autres aspects du travail archéologique et anthropologique peuvent être adaptés et appliqués à une enquête sur les lieux d'un incendie mortel pour optimiser la récupération et l'interprétation des preuves. L'application de certaines de ces techniques demande d'avoir des preuves de leur valeur et des recherches concernant la meilleure façon d'utiliser ces systèmes. Ces pistes de recherche et les besoins sectoriels décelés seront abordés pour déterminer quelles autres recherches pourraient être utiles.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Fatal fire, Forensic Investigation, Archeological Methods, Arson,